IDENTIFICATION OF OWNER'S PROJECT VALUE INTERESTS

A Thesis

by

MOLLY GAYNELL GUNBY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2010

Major Subject: Civil Engineering

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Approved by:

Chair of Committee,	Ivan Damnjanovic
Committee Members,	Stuart Anderson
	Sarel Lavy
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ABSTRACT

Identification of Owner's Project Value Interests. (December 2010)

Molly G. Gunby, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Ivan Damnjanovic

Identifying the unique ways in which a project can add value to an owner's organization is an essential part of project delivery. Every project has defined requirements, such as budget, schedule and engineering specifications that must be met; but there are other attributes of a project that are not always immediately evident; yet, when implemented, can add significant value. A delivered project that meets cost, schedule, engineering and operational requirements is not necessarily a project that provides the most value possible. To maximize the value of a project, it is first necessary to identify the ways in which it *can* add value. Only after that can an effective strategy be developed to exploit fully the value-adding potential of a project. However, because these value adding attributes, or *value interests*, are not always driven by operational or engineering requirements, they can be difficult to identify. Identification begins with understanding what aspect of a project drives the value interests. Since a single owner may engage in different types of projects and the value set of one may not be the value set of another, it is logical then to conclude it is characteristics of the project itself, not the owner, that drive the presence of value interest. It is this hypothesis, that *project characteristics drive value interests*, which is presented and validated in this thesis. The hypothesis is

supported through the development of a mathematical model in which the parameter estimates show specific project characteristics are significant in explaining the importance of individual value interests to a project. The model was developed through binary logistic regression of industry survey data, and validated statistically and empirically. A sensitivity analysis showed the key cost- and schedule-related value interests are not significantly sensitive, and an examination of the parameter estimates showed realistic and common sense relationships are present. The methodology presented here shows that value interests are, indeed, driven by *project* characteristics. However, there is neither a single characteristic nor a standard set of characteristics that drive all value interests. Instead, each value interest has its own unique combination of driving characteristics.

ACKNOWLEDGEMENTS

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CHAPTER I

INTRODUCTION

BACKGROUND AND PROBLEM

Identifying and communicating a set of project values that best represents the needs and expectations of the owner and key stakeholders is critical to successful project execution. Every project has unique attributes that enable it to not only meet operational or regulatory needs but also to add significant value to the owner's organization. To capitalize on a project's value adding potential, these unique attributes must be identified and shared among key stakeholders. Ineffective communication of value objectives can lead to misalignment both within the owner's internal project team and externally between the owner and contractor. Without a clear set of value objectives, the contractor may be left to assume what the owner's value needs are or to implement a broad or off-the-shelf response that wastes valuable resources and fails to meet the owner's expectations.

Identifying these value-adding attributes, or *value interests*, can be exceedingly difficult. This is because they are not always driven by engineering or operational requirements. Design attributes such as square footage or foundation specifications may be dictated by operational requirements or equipment needs; these are typically not difficult to define.

This thesis follows the style of the *Journal of Construction and Engineering Management*.

However, value interests may not be driven by the same engineering or operational requirements. Instead, they may be driven by higher level strategic needs, such as the need to rush a project in order to gain market share or the desire to seize the competitive advantage offered by development of a new technology. A delivered project that meets design and operational specifications is not necessarily a project that lives up to its value-adding potential. To achieve the most value from a project, it is first necessary to recognize all of the ways in which it *can* add value; only then, can the maximum value of a project, through exploitation of these attributes, be achieved.

The difficulty, then, arises of how to most effectively identify a project's value interests. Addressing this dilemma begins, first, with answering the question, *What drives these value interests*? Since a single owner may engage in many different types of projects and the value interests relevant to one project are not likely the same as those of another project, it is not the characteristics of the owner that drive them. It is, instead, characteristics of the project itself that determine which value interests are present on a project. Thus, it is this hypothesis, that *project characteristics drive value interests*, which is presented and tested in this thesis.

THESIS OBJECTIVE

The objective of this thesis is to test the hypothesis that *project characteristics drive value interests*. To accomplish this, it must be shown that there is a numerical relationship between project characteristics and value interests. Specifically, it will be shown, through development of a mathematical model, that a particular set of project characteristics are significant in explaining the applicability of individual value interests to a project.

The methodology required to develop the mathematical model and test the hypothesis included the following activities:

1. Generation of data.

   In this step, the value interests and project characteristics were enumerated and defined. Industry professionals were then surveyed to obtain project data and value interest preferences.

2. Development of model.

   In this activity, the survey data was processed, the parameters were estimated, and the resulting model was validated. The modeling method used to analyze the data was the binary logit model.

3. Testing of Hypothesis.

   The estimated parameters were examined to determine if they support the proposed hypothesis. This included interpreting the parameters and ensuring they reflect realistic and intuitive relationships.

In 2008, the Construction Industry Institute (CII) commissioned a research team to develop a method to assist owners in identifying and communicating project value interests and to aid the engineering and/or construction (E&C) provider in identifying an appropriate value interest response strategy. The efforts of the CII study provided the value interest, project characteristic, and survey data required to complete activity 1 described above. For more information regarding the CII study, see Damnjanovic, et al (2010).

THESIS STRUCTURE

This thesis is organized into eight chapters. Chapter I introduces the research problem and thesis hypothesis. Chapter II outlines the research methodology, including how the thesis hypothesis was tested. Chapter III provides an overview of current research into identifying and implementing value-adding project practices, as well as outlines applications of the binary logit model. A detailed discussion of the enumeration of value interests and project characteristics, the industry survey, and the survey population are provided in Chapter IV. Chapter V derives the binary logit model and presents the methodology of model development. The result of the hypothesis test, as well as an interpretation of model parameter estimates, is provided in Chapter VI. The CII ValueShare Tool and its uses are briefly introduced in Chapter VII. Finally, Chapter VIII summarizes the work presented in this text and provides conclusions.

CHAPTER II

RESEARCH APPROACH

The goal of this thesis was to test the hypothesis that project characteristics drive value interests. This was accomplished by showing the presence of a mathematical relationship between project characteristics and value interest. There were three primary phases required to develop and validate this relationship: 1.) Generation of data, 2.) Development of model, and 3.) Testing of hypothesis. The specific activities carried out during each of these phases are shown in Fig. 1.

The first phase revolved around obtaining the necessary data to develop a value interest model. This included identifying the project characteristics most likely to drive value interests and enumerating and defining the value interests that would be included in the model. Once this was accomplished, a survey of owner, contractor, and supplier companies was conducted to obtain project description data and capture value interest preferences.

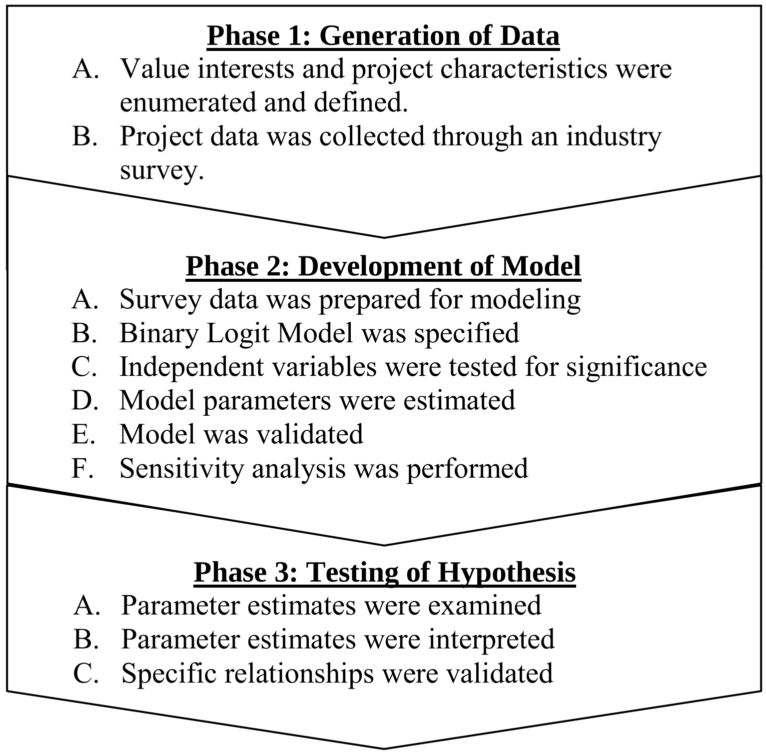

Fig. 1. Three Phases of the Research Approach

In the second phase, the survey data was prepared for modeling and an appropriate modeling method was selected. The project characteristics (independent variables) were tested individually to ensure only those that were significant in explaining the value interests were utilized and the model parameters were estimated using a binary logistic regression of the survey data. The resulting model was validated to ensure the value interest recommendations were realistic and reflective of the preferences expressed by the survey respondents. In the final step in this phase, the cost and schedule related value interests were tested for sensitivity to errors in their parameter estimates. This was accomplished by constructing a 95% confidence interval and observing the model recommendations when the parameters were at the estimated, lower, and upper boundary values.

In the final phase of the research approach, the model was used to test the validity of the proposed hypothesis. An examination of the parameter estimates was carried out to show which characteristics were drivers of specific value interests. Interpretation of the parameter estimates provided an intuitive meaning and demonstrated the direct effects of changes in the characteristics. The final step in validating the hypothesis was the examination of the parameters to ensure the expected and common sense relationships were present.

In the next chapter, a literature review outlines current efforts in identifying and maximizing project value and discusses applications of the binary logit model. The activities outlined in the research approach in the current chapter are discussed in greater detail in Chapters IV, V, and VI.

CHAPTER III

LITERATURE REVIEW

There has been much research effort into identifying value-adding practices and successfully incorporating them into project execution and delivery. Berman (2006) developed the *Speed2Value*™ Road Map, a comprehensive process designed to help organizations focus on and achieve the strategic value of a project. The process is broad enough to be used in any industry and provides guidance on identifying the project's value drivers, documenting measures to gauge project success, and following through to maximize the project's benefits during its whole life cycle, among other activities. The Road Map does not provide recommendations of specific project values but, instead, provides guidance to assist an organization in developing their own.

The Construction Industry Institute has also been a sponsor of a number of research projects investigating value-adding practices. The *Value Management Toolkit* (O'Connor et al. 2003) is a comprehensive tool that provides guidance on value-adding practices. The toolkit includes guidance on selecting the appropriate practice and the optimal time to implement. The *Cost-Schedule Trade-off Tool* (Gokhale et al. 2006) identifies techniques to meet specific cost- or schedule-driven objectives at each project phase. *Owner's Role in Project Success* (Griffis and Bates 2006) developed a tool to help owners identify the project areas in need of greater attention. *Planning for, Facilitating and Evaluating Design Effectiveness* (O'Connor et al. 2007) and *Maximizing*

Engineering Value (O'Connor and Singh 2009) were developed to assist organizations in identifying design and engineering strategies that enhance achievment of project objectives and maximize the value of the project. These resources have significantly advanced the practical knowledge of value-added design and management, however, there is still lacking a methodology which can identify and recommend a unique set of value-adding project elements based on specific project characteristics.

An important part of the methodology of this thesis revolved around understanding the value interest choices managers make in different project environments and this was achieved through the distribution of a survey. When surveys are conducted to capture choice data, the selections available to survey participants are often limited to a small number of discrete and unordered options. Frequently, this is the case with surveys on the usage of household products, choices of travel modes or routes, and preferences of news and media sources. These surveys can generate valuable information for companies on the criteria people use to evaluate and choose among their products or allow them to tailor their advertisement to a specific audience. Surveys can also provide transportation officials the vital road utilization data they need to make funding decisions. Analysis of past choice behavior can be used to *predict* future behavior such as how a consumer will respond to a new product or how likely people will be to use a new toll road. Thus, choice data was collected from industry professionals to *predict* the value interests that would be appropriate to a given project.

Discrete Choice Analysis (DCA) is a type of method used to model ordered and unordered choices. The DCA outcome is the probability that a particular choice will be made. As stated previously, DCA has been used extensively to model transportation choices. According to Ben-Akiva and Lerman (1985), DCA was used as far back as the 1960's to examine binary travel mode preferences and its utilization expanded significantly in the 1970's to include multi-choice (more than two) modal preference, vehicle ownership, and other transportation related choices.

The numerical method used to perform the analysis depends on several factors including the type of dependent or the outcome variable. When the outcome variable is limited to a set of discrete or binary selections, ordinary linear regression is not a suitable option. This is because when the dependent variable is dichotomous, linear regression frequently results in predicted probabilities greater than 1 and less than 0. Instead, the logistic regression model is a widely accepted alternative for this type of numerical analysis (Hosmer and Lemeshow 2000). The logit model ensures realistic predicted probabilities, between 0 and 1, as well as has the appealing attribute of computational simplicity (Kennedy 2003). The terms logit model and logistic regression usually refer to the form in which the numeric expression takes. When solved for its log-odds, it is usually called a logit model and when solved for its probability, it is called a logistic regression model, though occasionally the difference in designations is also used to describe the type of independent variable used in the model (Futing Liao 1994). When the dependent variable can only take on one of two values, it is called a binary logit model or binary logistic regression.

The logit model, or logistic regression, has been applied in a variety of disciplines. Schmidt and Strauss (1975), used a mulitple logit model to analyze the effects of race, sex, education, and years of labor experience on the level of occupation attained and to show the presence of racial and gender discrimination in occupational opportunity. de Dios Jiménez and Salas-Velasco (2000) used the logit model to explore the relationship between a student's decision to pursue either a three or four year degree and their economic, social, and educational backgrounds. Logistic regression has also been used to predict the existence of a species of interest within a particular range for the purpose of wildlife and conservation management. Pearce and Ferrier (2000) demonstrated methods to evaluate the reliability and discrimination capacity of these models to predict the existence (or non-existence) of a species in a geographical region. The binary logistic regression model has applications in medical science. A ten year study performed at Hôpital Henri Mondor in Créteil, France, was able to conclude that stopping a causative drug at the first definitive sign of toxic epidermal necrolysis or Stevens-Johnson Syndrome (versus stopping later) decreased the chance of patient death after performing a retrospective binary logistical analysis of patient data (Garcia-Doval et al. 2000). King and Zeng (2001) examined the application of logistic regression to rare events in which the occurrence (versus the non-occurrence) of the event is excdeedingly uncommon (such as with epidemiological infections and war) and the resulting bias that occurs in coefficient and standard error estimates and predictions and demonstrates a computational and sampling strategy to correct for these biases.

CHAPTER IV

DATA

VALUE INTERESTS

As stated previously, the data required for this thesis was generated during the course of a CII project. The CII research team defined a value interest as *an owner defined project attribute that adds some measure of value to their organization*. These attributes may be common requirements found in nearly all projects, such as cost and schedule, or they may be project attributes specific to an industry or dictated by the owner's business strategies, such as the public image of the project or protection of intellectual property.

Selection of the value interests was a critical step. It was important to include value interests that are general enough to apply to any industry, as well as include a set of more specialized value interests to capture the unique requirements that make one project different from another. Therefore, substantial effort was put into selecting these value interests.

Initially, the CII research team enumerated a list of nearly 70 value interests. Existing literature was also reviewed to identify any concepts that may be applicable as value interests; however, those that were identified as potential value interests were already present in some form in the set already identified. After eliminating those that were redundant, the initial list of almost 70 value interests was reduced to 48. Safety is always the most important value interests and should never be displaced by any other value interest; therefore, it was not included as a variable in the model.

Since the interpretation of the value interest terms may vary from one organization to another, it was critical to develop standard definitions for each. Definitions for the 48 terms were developed using the expert opinion of the industry members of the CII team. Initial definitions were developed and after several iterations of review and revision, consensus was reached among the research team. In addition, it was important that the terms were defined in the context of the value they can add to the project or owner's organization. As a result, each value interest definition has essentially two parts. One part provides the meaning of the value interest and the other part expresses the potential benefits of the value interest. For example, the definition of *Flexibility to defer project* is

"The ability to phase project construction and delivery to allow an owner to stage funding or address uncertainties such as changing scope or market requirements."

What the value interest means is that it provides *the ability to phase construction and delivery*. How it benefits and why it is important to the project is that it *allows an owner to stage funding or address uncertainties*.

One benefit offered by the identification of value interests is the promotion of communication at a granular level. This is important, in particular, because historically value interests have been defined in somewhat broad terms. The level of detail of communication can be described as being in one of three levels of granularity, as shown in Fig. 2. At the macro, or broadest, level the overriding priority (excluding safety) of nearly every private sector project is return on investment (ROI) or, equivalently, for public sector projects is the benefit cost ratio (B/C). Every owner desires the highest possible return on project funds; however, this conveys nothing of the owner's project-level value expectations. Communicating cost, schedule, and quality as priorities, while somewhat more granular and descriptive than ROI or B/C, still does not communicate sufficient information to allow the E&C to formulate a successful response to a value interest.

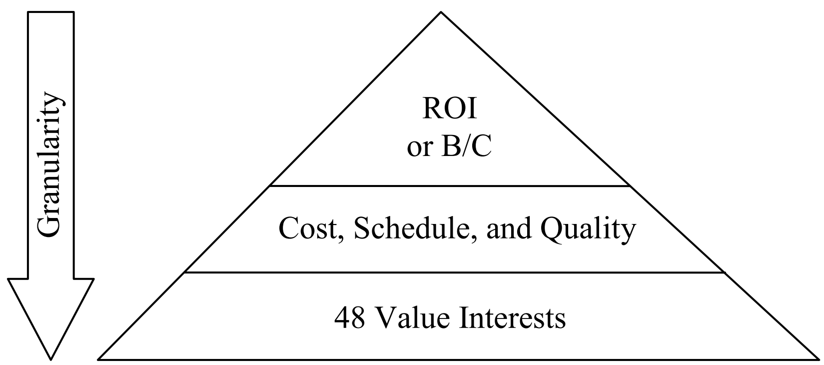

Fig. 2. Value Interest Pyramid

The 48 value interests developed, shown at the bottom of the pyramid, represent the highest level of granularity of information. This is the micro level of communication. At this level, value needs and expectations are more specific and unambiguous. They are well defined and achievement of them can be strategized and measured. Encouraging this level of communication is one of the primary benefits of the model.

PROJECT CHARACTERISTICS

Identification of a set of recommended value interests is dependent on how the project is described. Since jargon varies widely among industry sectors, and even among owners and contractors in the same industry sector, it was important to establish a standard description language that is both specific enough to capture the fundamental characteristics of a project and broad enough to be applicable to all projects and industries. In addition, because a single owner may execute a variety of projects, the characterization should be limited solely to the project and not the owner.

Thus, selection of the appropriate project characteristics was a critical step. The CII team considered not only what are the key features essential to understanding a project but also what are the features of a project that affect its ability to add value to a project and organization. Recognizing this important distinction, they defined a project characteristic as *a feature that affects, governs, or determines a value interest(s)*. With the formal definition as guidance, twelve project characteristics were identified to represent the fundamental nature of the project as well as the aspects of a project that are the strongest drivers of value interests. Although a few of these characteristics do include references to the owner, they are in the context of the project. The twelve characteristics are shown in Table 1.

Table 1. Project Characteristic Definitions

Project Characteristic	Definition
Industry	The owner or project industry type.
Location	The project location relative to owner's current operations and existence of infrastructure.
Size	The total cost of the project, expressed in US dollars.
Technology	The degree of technology maturity and complexity of implementation, including modifications required and the extent of owner and contractor experience.
Complexity	The degree of complexity of design, construction, and funding, including utilization of new/unfamiliar design or construction tools and methods, and level of scope definition, and funding source(s).
Project Nature	The nature of the work to be done and the extent of the change to the facility.
Type of Project	The scope of work/services for which the contractor will be responsible.
Owner's Involvement	The degree of owner participation and control of design.
Strategic Importance	The extent to which the project impacts the enterprise strategic drivers.
Cost Driven	The extent to which cost is the key value interest and is the prime consideration for project decisions.
Schedule Driven	The compression of project completion time relative to the typical completion times of other projects with similar scope.
Regulation	The impact of regulatory compliance on the project.

The CII team then defined each characteristic (except Industry) by assigning it five possible choices, or levels. These five levels represent an ordered, increasing scale from some low, or baseline, degree to a high degree. For example, the five choices for the characteristic *Technology* are shown in Table 2.

Table 2. Five Choice Levels of Technology Characteristic

Choice Level	Choice Description
1	It is common and/or repeatable, the owner has extensive experience with it, and there are no anticipated complications.
2	It will require modification/scaling of existing technology, the owner has extensive experience with it, and there are no anticipated complications.
3	It has average maturity and/or complexity and the owner has some (but not extensive) experience with it.
4	It has limited commercialization and/or unknown scalability and the owner has limited experience with it.
5	It is ground-breaking with no previous commercialization and the owner has no experience with it.

The levels were chosen to capture the increasing complexity and effort necessary to meet the project's technology needs. The levels for the other ten characteristics are similar in their design except for *Industry*. The *Industry* characteristic was given eight, non-ordered levels which represent eight different industry types. The levels for all twelve characteristics are listed in Appendix A.

SURVEY

A survey was developed to collect the data necessary to establish the relationship between value interests and project characteristics. It was distributed to owners, contractors, and suppliers with the assistance of CII and the Construction User's Round Table (CURT) during the spring and summer of 2009. The survey was directed at project managers or executives that have experience with both the engineering and business requirements of a project. It was important to capture both the owner's and the contractor's perspective of what drives a project's values because an owner has insight into operations and strategic business requirements while a contractor may have insight into project delivery and execution requirements that an owner may not. It is important to note that the contractors were instructed to answer the survey questions from the perspective of the owner or, in other words, as if they were the owner.

There were three steps in the survey. The first step asked the participant to consider a project with which they have experience and then describe their project by selecting one of the five (or eight) levels for each of the twelve project characteristics. In the second step, they were presented with the 48 value interests (with definitions) and asked to select the ten they believed were the most applicable to the project they described. In the final step, the participant was asked to assign a weight to each of the ten selected value interests. The weights of all ten value interests were required to sum to 100 and individual weights represented the relative importance of each value interest to the project. Participants were asked to complete the survey for up to three projects. A copy of the survey is provided in Appendix B.

The survey was sent to 100 CII companies. Of these, 22 companies participated and most had more than one individual respond. In fact, 81 responses were received and these provided data for 186 different projects. It is unknown how many surveys were sent to CURT members. Responses were received from two individuals from two CURT companies and they provided data for four projects.

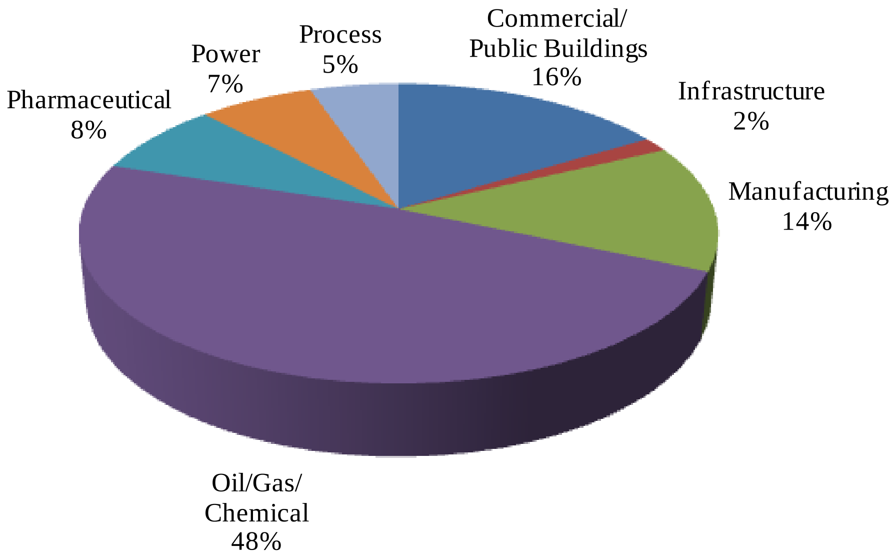

Fig. 3. Industry Representation of Survey Respondents

In total, 83 individuals provided data for 190 projects. Fig. 3 shows the representation of participating industries. This does not include contractor participants, as a single contractor may engage in projects in many diverse industries. In comparison, the industry representation of CII owner company membership is shown in Fig. 4. As can be seen, the representation of the pharmaceutical, commercial/public buildings, and infrastructure industries in the survey are the same or very similar to the CII membership makeup. The manufacturing and oil/gas/chemical industries, however, are over-represented while the power and process industries are under-represented when the survey responses are compared to CII membership.

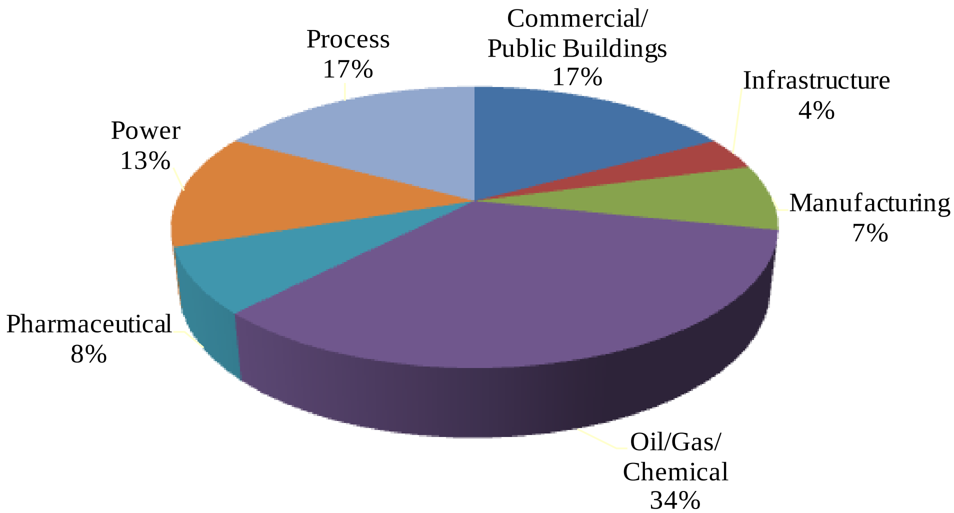

Fig. 4. Industry Representation of CII Owner Company Members

Half of the project responses were provided by owner companies and the other half by contractors. To determine if inclusion of contractors in the study resulted in a skew of the collected data, the value interest choices of the two groups was compared. Since each group provided 95 projects and there were ten value interest selections provided by each project, each group chose a total of 950 value interests. An examination of the frequency with which each value interest was chosen by each group revealed that the selections of both groups (at the aggregate level) were markedly similar (see Figs. 5 and 6).

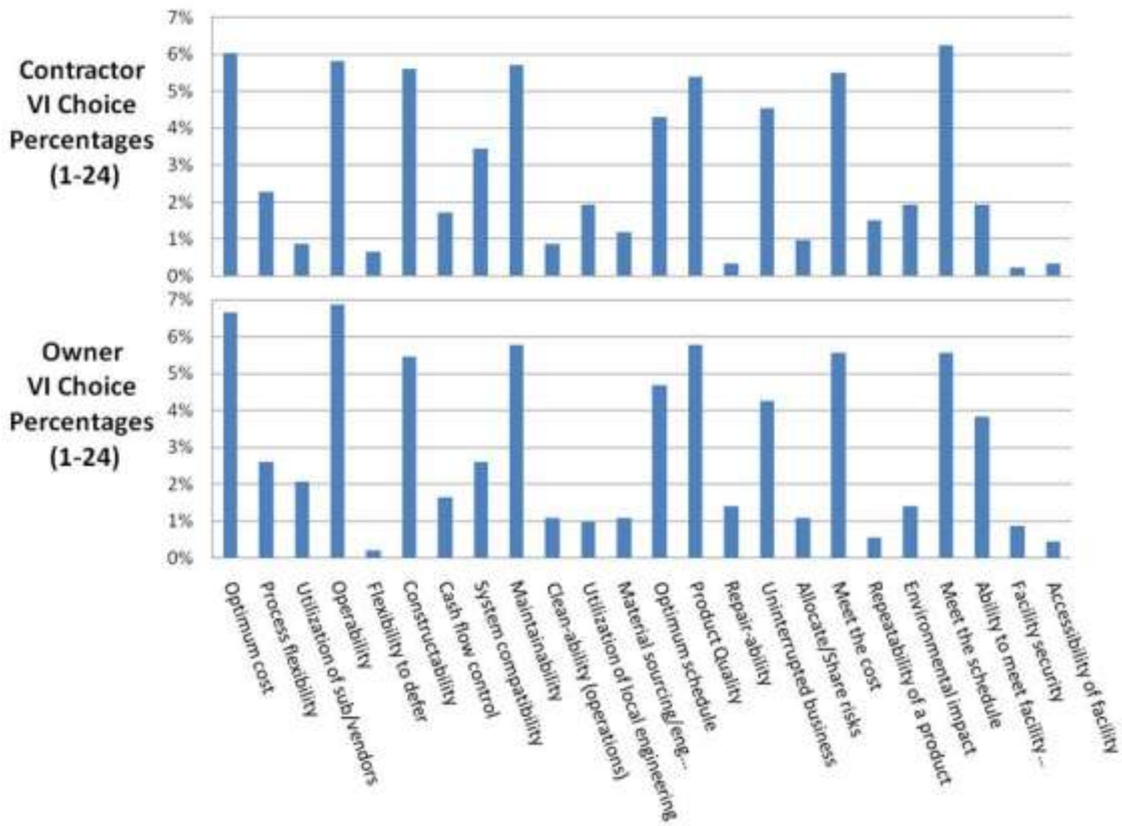

Fig. 5. Choice Frequencies of Owner and E&C Survey Participants (First 24 Value Interests)

Though the value of the frequencies was not identical, there was a distinctly similar pattern between the two groups. The value interests that were chosen most frequently by the owner participants were also the ones chosen most frequently by the contractor participants, with the exception of three value interests. Of the 950 value interests chosen by the contractor participants, almost 6% were *Design team experience/competency*, while, the owner participants chose this value interest just over 2% of the time (see Fig. 6). This may be because a large portion of contractor business is design work and, therefore, the contractor participants feel owners highly value the experience of the design team. Another outlier value interest, *Stakeholder's involvement*, was chosen with approximately 1% frequency by contractors and almost 2.5% frequency by owners. This may be a reflection of the difficulty in obtaining buy-in from all organizational levels within the owner's organization.

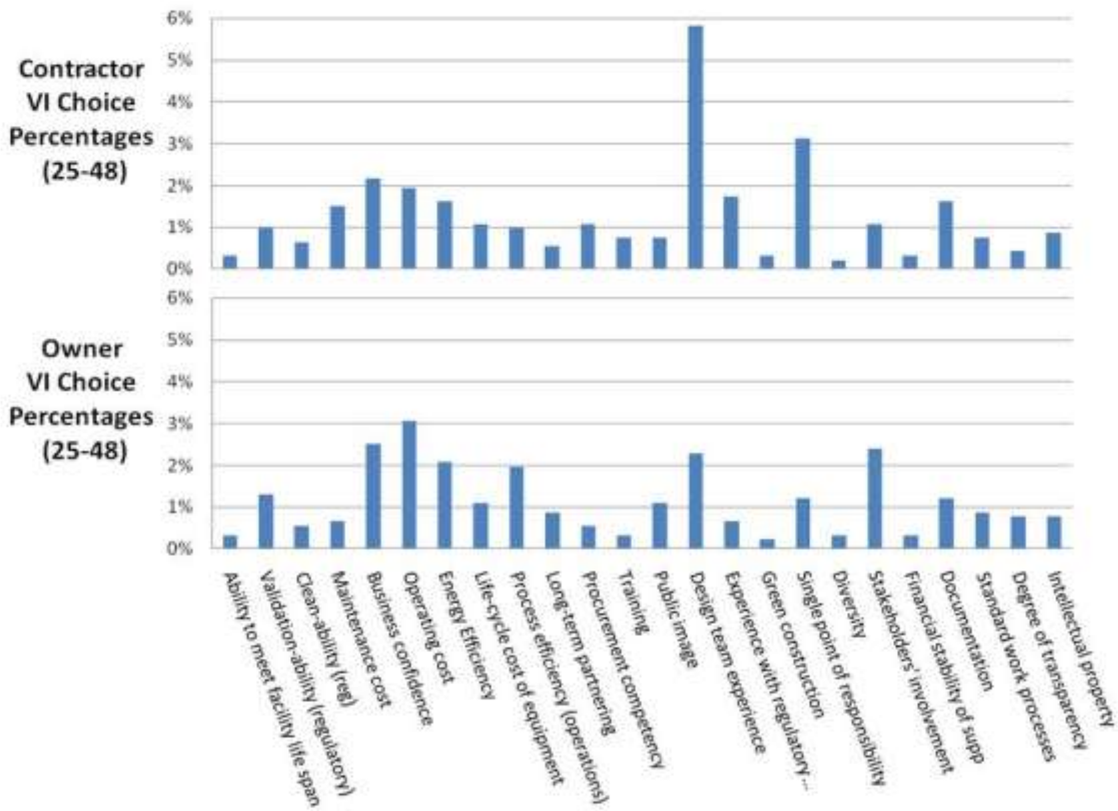

Fig. 6. Choice Frequencies of Owner and E&C Survey Participants (Last 24 Value Interests)

A third difference was observed in the choice percentages of *Single point of responsibility for project execution*. This value interest was chosen just over 3% of the time by contractors and just over 1% of the time by owners. This may stem from the frustration contractors experience when there are multiple contact points with the owner's organization. Overall, the value interest choice frequencies were sufficiently similar to conclude that inclusion of contractors in the survey did not skew the data. The comparison was made at an aggregate level, however, and did not take into account the project characteristic selections associated with the value interest choices.

CHAPTER V

MODEL DEVELOPMENT

DATA PROCESSING

Each project response provided an array of project characteristics and ten weighted value interests. The objective was to obtain a numerical model to express the relationship between the characteristics and the value interests. Before this could be accomplished, the survey data had to be transformed into a suitable form.

The five characteristic levels represented an increasing scale; therefore, each level was assigned a value between 1 and 5 to reflect its position within the five levels. The value 1 represented the lowest level and 5 represented the highest. The characteristic *Industry* was a categorical, not a scaled, variable. Because of this, the data collected was not sufficient to include this variable as a regressor in the model.

Another transformation was required to prepare the data. Though responses were provided for 190 projects, given the dependent variable (value interest) had 48 possible choices, this was a relatively small sample size. To overcome this, the survey data was resampled according to the weights assigned by the survey participants. Recall, in the survey the participant was asked to weigh each of their ten selected value interests so that the weights of all ten summed to 100 and the individual weights reflected the relative importance of the given value interest. Using these value interest weights, the responses were resampled and the data set expanded in an operation similar to statistical bootstrapping. For example, if the data shown in Table 3 were a survey response, then that response would produce 100 data points in the data set with that combination of project characteristic levels. Twenty of the data points would be treated as having a value interest choice of *Optimum cost*, ten would be treated as having a value interest choice of *Design team experience/competency*, etc. The final data set was a table in which each row represented a data point, the first twelve columns displayed the chosen level for each characteristic, and the final column displayed the single value interest choice. The result of this replication exercise was that, for the purpose of data analysis, a data set containing 190 projects was transformed into a data set with 19,000 data points. This increase in the data set allowed for more robust model estimation and reduced the chance of losing some of the significance of the lesser chosen variables to random model noise.

Table 3. Example Survey Response

Project Characteristic	Selected Level	Selected Value Interest	Assigned Weight
Industry Type	8	Optimum cost	20%
Location	1	Design team experience/competency	10%
Size	3	Standard work processes	5%
Technology	4	Constructability	5%
Complexity	2	Allocate/Share risks	10%
Project Nature	3	Meet the schedule objective	15%
Type of project	1	Product Quality	10%
Owner's Involvement	1	Procurement competency	5%
Strategic Importance	1	Single point of responsibility for project execution	5%
Cost Driven	5	Meet the cost objective	15%
Schedule Driven	1	Sum	100%
Regulation	2		

BINARY LOGIT MODEL

As both the ordinary linear model and the logit model are members of the family of Generalized Linear Models (GLM), the easiest explanation of the second begins with the form of the first. When the expected value *E(Y)* of a random variable, *Y*, is given

$$E(Y) = \mu \tag{1}$$

its expression in terms of a set of independent, or explanatory, variables is written

$$E(Y) = \mu = \sum_{i=1}^{n} \beta_i x_i \tag{2}$$

where β represents a vector of n unknown parameters and x a vector of explanatory variables. As shown, the expected value of the random variable is linearly related to its predictors. The logit model follows a similar form except it is not linearly related to its predictors. Instead, it is related to its predictors through use of a link function, η, where η is linearly related to the predictors (Futing Liao 1994)

$$\eta = \sum_{i=1}^{n} \beta_i x_i \tag{3}$$

and related to μ through the expression

$$\eta = \log \frac{\mu}{\mu - 1} \tag{4}$$

Using Equations 3 and 4 and assuming a binary dependent variable, the expected probability that an event will occur (versus not occurring), *or the probability Y = 1*, can be shown as

$$\log \frac{P(Y=1)}{1 - P(Y=1)} = \sum_{i=1}^{n} \beta_i x_i \tag{5}$$

This expression, containing the logit term on the left side, is commonly called a *logit model* (Futing Liao, 1994). With a few simple algebraic operations, Equation 5 can be solved for the probability that the event will occur:

$$P(Y=1) = \frac{e^{\sum_{i=1}^{n} \beta_i x_i}}{1 + e^{\sum_{i=1}^{n} \beta_i x_i}} \tag{6}$$

The term *logistic model* is used when the model takes the form shown in Equation 6 (Futing Liao 1994).

In the context of the problem presented in this thesis, the probability of an event occurring is the probability that a given value interest is applicable to a particular combination of project characteristics. The twelve project characteristics are represented in the model by the vector of explanatory variables (x_1: x_{12}) and the unknown parameters are estimated through regression of the survey data. Thus, once the parameters are known, the project characteristics (x_1: x_{12}) can be changed to describe different projects and the probability a value interest is important to that project can be obtained using the expression in Equation 6.

PARAMETER ESTIMATION

Logistic regression model parameters are estimated using the maximum likelihood estimation method (Ben-Akiva and Lerman 1985; Long 1997; Hosmer and Lemeshow 2000; Menard 2002; Kennedy 2003; Ryan 2009). Given that a series of *n* independent observations of the dependent variable are conditional on a series of vectors of explanatory variables, the likelihood function is simply the joint conditional probability density function of the observations. When the dependent variable is either a success or failure or can only take on the values 0 or 1, it can be described as a Bernoulli random variable. Using the customary simplification so that the expected value of *Y* given a vector of independent variables x_i is $P(Y/x) = \pi$, the joint conditional probability density function, and *likelihood function* given a set of parameters β, is expressed

$$p(Y_1, Y_2, \ldots, Y_n) = l(\beta) = \prod_{i=1}^{n} \pi_i^{Y_i} (1 - \pi_i)^{1-Y_i} \tag{7}$$

where π_i^{Yi} is the probability that $Y_i = 1$, given the vector $\boldsymbol{x}$, and $(1-\pi_i)^{1-Yi}$ is the probability that $Y_i = 0$. These probabilities follow from Equation 6 and, therefore, estimates for β are chosen such that they maximize the value of the expression in

Equation 7. This expression, however, is most commonly used in its *log* form because it is simpler to use:

$$\max\{\log[l(\beta)]\} = \max\{\sum_{i=1}^{n} Y_i \log(\pi_i) + \sum_{i=1}^{n}(1-Y_i)\log(1-\pi_i)\} \tag{8}$$

If there are j independent variables, the equation in (8) is differentiated $j+1$ times with respect to β_0, β_1,... β_j, where β_0 is an intercept term and $\beta_1 : \beta_j$ are parameters of the independent variables. Setting each of the j equations equal to zero and iterating them simultaneously will give values for $\boldsymbol{\beta}$ that maximize the log likelihood. Many commercial software and freeware packages have built-in functions to perform this operation.

MODEL SPECIFICATION AND ESTIMATION RESULTS

The binary logit model, as expressed in Equation 6, gives the probability that a particular choice will be made given a specific combination of independent variables. In the context of this thesis, this means the output of the binary logit model is the probability that a single given value interest is applicable to the project versus all other value interests. In other words, it gives the *marginal probability* that one value interest is applicable versus the remaining 47 value interests (but not versus any *one* specifically). Thus, it was necessary to perform the estimation 48 times, once for each value interest. This model arrangement was selected because it enables direct observation of the influence of individual characteristics on the importance of specific value interests. It also allows examination of each characteristic for its statistical contribution to each value interest model.

Obtaining the *marginal* model specification was an iterative process because not all characteristics were statistically significant in explaining the value interest choices. The first model performed for each value interest included all eleven characteristics. The contribution of each characteristic was then reviewed to determine if it would be retained or omitted and the estimation was repeated with the reduced set of characteristics to obtain a new set of parameters. Thus, for a given value interest, there may be fewer than eleven parameters.

The marginal model and its components were validated in two ways. First, the individual characteristics were checked for statistical significance. Second, the marginal model obtained with the reduced set of characteristics was tested for fit. The first regression performed for each value interest included all eleven characteristics. The Wald test was performed and using the p-value, the characteristics that did not contribute significantly were removed from the model in a backward, stepwise fashion. After each regression, if a characteristic had a p-value greater than 0.05 it was removed and the regression was performed again. Only one characteristic was removed at a time until all remaining characteristics were statistically significant. This exercise ensured that there was less than a 5% probability that the intercept alone could produce the observed value interest choices as well or better than the project characteristics retained in the model.

To gauge the overall fit of the final set of parameters, it was tested versus a null model using the chi square test. The chi square statistic was calculated by taking the difference between the deviance statistic (-2 log likelihood) of the test marginal model and the null marginal model containing only the intercepts. The degrees of freedom was taken as the difference in the number of parameters between the two marginal models. If the p-value, found using the chi square statistic and degrees of freedom, was less than 0.05 then the null marginal model was rejected and the marginal model was retained. Both of these validation procedures were repeated for all 48 marginal value interest models.

The result of the marginal model specification and estimation is shown in Appendix C. The first column of parameters is an intercept term and the remaining eleven are parameter coefficients of the characteristics. If a characteristic was not statistically significant for a particular value interest, there is no entry for that parameter in the table.

Given a project description, Equation 6 calculates the marginal probability of a value interest. However, since the probability (*P*) is that of a single value interest being applicable, then (*1-P*) is the probability that the given value interest *is not* applicable or, equivalently, that any of the other 47 value interests (but not any one specifically) *is* applicable. Clearly, the sum of all of the marginal probabilities for the 48 value interests will be considerably greater than 1. It is the relative probability, however, that is most useful and, therefore, the marginal models were standardized and combined into a single *full model* so that all 48 relative probabilities sum to one. This standardization was performed by dividing each marginal probability by the sum of all of the marginal probabilities. Thus, the probability that a value interest is applicable in the full model is given by Equation 9.

$$P(Y_i = 1)_{Full} = \frac{P(Y_i = 1)_{Marginal}}{\sum_{i=1}^{n} P(Y = 1)_{Marginal}} \tag{9}$$

Since the probabilities given by the full model represent the relative applicability (they all sum to one) of each value interest, the full model probabilities can be used to arrange the 48 value interests in order of applicability or importance to given project.

MODEL VALIDATION

The statistical validation discussed previously showed the logit model was a good fit of the observed survey data. To determine if the model actually produced realistic, intuitive results, it was necessary to test it using real project data. First, nineteen survey responses (10% of the number received) were randomly selected and the project descriptions were entered into the model to compare how the model recommendations (value interests ordered from highest to lowest probability) matched the choices made by the survey respondent. The result was that for 75% of the nineteen projects tested, at least five value interests in the top ten recommended by the model matched those chosen by the survey respondent; almost 30% matched at least seven out of ten. When the top five recommended by the model were compared to the five highest weighted in the survey responses, approximately 65% matched three or more out of five and almost 20% matched four or five out of five. Finally, the top three recommended by the model were compared to the three highest weighted and over 80% matched two or three out of three.

The significance of this test is that the model is not only a good fit of the survey data, it also yields recommendations comparable to those made by experienced industry professionals. In addition, it is considerably accurate in predicting the few most critical value interests.

SENSITIVITY ANALYSIS

There is always some element of uncertainty and randomness in model estimation. The uncertainty can be reduced by selecting a model that provides a good fit of the observed data but it can never be completely eliminated. Since data variance can affect the output of the model, it is important to establish how significant the effects may be. For this reason, some recommendations made by the model were tested to determine how sensitive they are to changes in the values of the project characteristic parameters (independent variables). The two value interests *Meet the cost objective* and *Meet the schedule objective* were selected since cost and schedule are always a significant project concern and they were among the most frequently selected value interests in the survey.

Some characteristics are stronger drivers of these two value interests than others and, thus, errors in their estimates can more significantly impact the output of the model. The strongest drivers of *Meet the Cost Objective* are the project *Type*, the extent of *Regulation* on the project, and the extent to which the project is *Cost driven* (see table in Appendix C). It is expected that the extent to which the project is *Cost driven* would be a strong driver of a cost related value interest. The project *Type* refers to the scope of work for which the contractor will be responsible. The greater the scope of work allocated to the contractor, the less control the owner has over cost escalation. It is reasonable to see how this delegation of cost control to another party would make meeting the specified cost objective a higher priority to an owner. Similarly, when a project is highly regulated, the owner may have little control over funding of certain parts of the project.

The value interest *Meet the Schedule Objective* has four strong drivers: the project *Size*, the project *Complexity*, the extent of owner *Involvement* in the project, and whether the project is *Schedule driven*. Clearly, a schedule related value interest will be important to a schedule driven project. When a project becomes highly complex, meeting both the cost and the schedule may become less certain; schedule, however, was revealed by the survey to be more strongly driven by the *Complexity* characteristic.

To test the sensitivity of these two value interests, a 95% confidence interval was developed for the parameter estimates. The upper and lower boundary estimates for each of the characteristics were then used in the model to see how the overall ranking of the two value interests change. The overall ranking refers to where the value interest is in the prioritized list of 48.

The analysis was performed using a case study project. The case study project was the installation of a new cogeneration unit within an existing refining facility. The new cogeneration unit will produce 35 MW of electricity from natural gas and 330,000 pounds of 700˚F steam per hour for use elsewhere in the refinery. The project has a schedule of 19.5 weeks and a cost of $50 million. It includes relatively common, straightforward technology and average complexity, importance, and regulation. It was moderately driven by both cost and schedule and the contractor was responsible for all but front-end development. The project description is provided in Table 4.

Table 4. Description of Case Study Project

Characteristic	Characteristic Level - Description
Project Location	1 - It is an established location with existing infrastructure and owner operations or presence.
Size (USD)	2 - $10M to $50M
Technology	1 - It is common and/or repeatable, the owner has extensive experience with it, and there are no anticipated complications.
Project Complexity	3 - Complexity is medium; project uses established design tools and/or process steps, some new design specifications are required and there are some deficiencies in the scope of work/project definition.
Project Nature	1 - It is an add-on project constructed on a Brownfield site. The project will add extra processing steps where a process did not previously exist.
Type of Project	4 - The E&C is responsible for DE, Procurement, Construction (design development, material purchasing/ expediting/ inspection/ logistics and construction) but not FEED.
Owner's Involvement	2 - The level of owner involvement is low. The Owner is performing the conceptual engineering; remaining design, procurement, and construction is performed by the E&C.
Importance	3 - The importance of the project is medium.
Cost Driven	4 - Cost is a moderate factor; this is a typical project in which cost must be held in check based on the initial estimate and allocated funds.
Schedule Driven	3 - There is between 5% and 10% schedule compression and some deviation from normal or accepted scheduling practices.
Regulation	3 - The impact of regulatory compliance on the project is medium.

The results of the analysis for *Meet the Cost Objective* are shown in Table 5. The ranking of this value interest, within the list of 48 value interests, did not exhibit significant sensitivity when the upper and lower boundary estimates were compared. It was ranked at the fourth position in the list of 48 for every lower boundary parameter tested. This is the same rank that is observed when the estimated parameter values are used. When the parameters were changed to their upper boundary values, the value interest moved in the ranked list by only one or two positions. Only seven characteristics were statistically significant to this value interest and, therefore, only these seven were tested.

Table 5. Sensitivity of Meet the Cost Objective

Project Characteristic	Parameter Estimate	Standard Error	Lower Boundary Estimate	Upper Boundary Estimate	Value Interest Rank (at estimated value)	Value Interest Rank (at lower Boundary)	Value Interest Rank (at upper Boundary)
Size	-0.08228	0.02617	-0.13357	-0.03099	4	4	3
Technology	-0.05897	0.02524	-0.10844	-0.00950	4	4	4
Type	-0.17533	0.03074	-0.23558	-0.11508	4	4	2
Involvement	-0.09135	0.02308	-0.13659	-0.04611	4	4	3
Cost	0.19785	0.02470	0.14944	0.24626	4	4	2
Schedule	0.08277	0.02170	0.04024	0.12530	4	4	3
Regulation	0.21204	0.03010	0.15304	0.27104	4	4	3

When the boundary analysis was performed for *Meet the Schedule Objective* (summarized in Table 6), the results showed this value interest is slightly more sensitive to errors in the parameter estimates but still not significantly so. In the base case (using the estimated parameters), it was ranked second (out of 48), meaning the model predicted it as the second most important to the project. Its rank varied, depending on which characteristic was under examination, between positions two and four when the lower boundary estimates were used. It remained at position one for eight of the nine upper boundary tests (only nine characteristics were significant to this value interest).

The characteristics *Complexity* and *Type* showed the most significant shift in ranking (from 4th to 1st) when the upper and lower boundary results were compared. This means the *Meet the Schedule Objective* model is slightly sensitive to the errors in the parameter estimates for these two characteristics and its recommended position could be affected if the parameter estimates are significantly different from the true values; however, since, statistically, the actual parameter estimates fall within the lower and upper boundary estimates with a 95% confidence, it is unlikely significant errors exist in the model estimations. In addition, although the value interest ranking moved from the 4th to 1st position when the upper and lower boundary estimates were compared, it only moved, at most, by two positions when the upper and lower boundary estimated were compared to the base case in which the estimated parameters were used.

Table 6. Sensitivity of Meet the Schedule Objective

Project Characteristic	Parameter Estimate	Standard Error	Lower Boundary Estimate	Upper Boundary Estimate	Value Interest Rank (at estimated value)	Value Interest Rank (at lower Boundary)	Value Interest Rank (at upper Boundary)
Size	-0.21150	0.02714	-0.26469	-0.15831	2	2	1
Technology	-0.09621	0.02627	-0.14770	-0.04472	2	2	2
Complexity	-0.18381	0.03438	-0.25119	-0.11643	2	4	1
Type	-0.06490	0.03035	-0.12439	-0.00541	2	4	1
Involvement	-0.24539	0.02310	-0.29067	-0.20011	2	2	1
Importance	0.12840	0.02899	0.07158	0.1852204	2	3	1
Cost	-0.09336	0.02016	-0.13287	-0.05385	2	3	1
Regulation	0.06944	0.03201	0.00670	0.1321796	2	3	1
Schedule	0.22935	0.02101	0.18817	0.2705296	2	2	1

CHAPTER VI

RESULTS

HYPOTHESIS OUTCOME

This thesis presented the hypothesis that *project characteristics drive value interests*. Development of the value interest model provided validation of this hypothesis. The value interest model also showed, however, that not every project characteristic drives every value interest. Since each characteristic was evaluated individually for its contribution to the marginal model, only those characteristics that were statistically significant were retained. This means that some marginal value interest models have fewer than 11 characteristics (independent variables) and the characteristics in one model are not necessarily the same for another model. In addition, every model has at least three contributing characteristics. Thus, this effort showed that, in general, project characteristics *do* drive value interests but that there is neither a single, overriding characteristic nor is there a standard set of characteristics that explain every value interest. Instead, each value interest has its own unique combination of contributing value interests.

INTERPRETATION OF PARAMETER ESTIMATES

Since the relationship between the explanatory variables and dependent variable is not linear, interpreting the parameter estimates in an intuitive manner requires solving equation 5 for the odds ratio (Futing Liao 1994)

$$\frac{P(Y=1)}{1-P(Y=1)} = e^{\sum_{i=1}^{n} \beta_i x_i} \tag{10}$$

and then rearranging to get

$$P(Y=1) = [1-P(Y=1)]e^{\sum_{i=1}^{n} \beta_i x_i} \tag{11}$$

where the left hand side is the probability that the value interest is applicable to the project and the right hand side is the probability the value interest is not applicable to the project multiplied by a proportional factor (*e* raised to the vector of parameters and characteristic levels). Using the coefficient for *Project size* in the *Cash flow control* model as an example, the proportional factor (*e* raised to 0.368) is 1.445. This means a one unit increase in the characteristic *Project size* will make the value interest *Cash flow control* 1.445 times more likely to be applicable than any other value interest (but not any one specifically).

VALUE INTEREST DRIVERS

An examination of the parameter estimates yielded valuable insight into the drivers of project value interests. Prior to modeling, there were several relationships that were expected; most of these were later confirmed by the parameter estimations. In addition, there were some unexpected relationships revealed.

Clearly, it would be expected that the *Cost driven* and *Schedule driven* project characteristics would be strong drivers of the cost and schedule related value interests. Further, the value interests *Meet the cost objective* and *Meet the schedule objective* should be more strongly influenced by these characteristics than the value interests *Optimum cost* and *Optimum schedule* since the former two represent the need to meet a specific goal while the latter two suggest that, although meeting the goal is important, there is willingness to make trade-offs to maintain equilibrium among all of the critical value interests. All but one of these relationships was supported by the parameter estimates. The parameter estimate for *Meet the cost objective* was 0.19785, larger than that of *Optimum cost*, which was 0.11593 (see table in the Appendix C). Remember that the higher the parameter value, the greater the characteristic contributes to the applicability of the value interest to the project. This means that as the project becomes more *Cost driven*, the value interest *Meet the cost objective* increases in importance more than *Optimum cost*. A high parameter was also observed for *Schedule driven* in the *Meet the schedule objective* model. However, the *Schedule driven* characteristic was not sufficiently statistically significant to be retained in the *Optimum schedule* value interest model and, therefore, the characteristic does not contribute to the importance of that value interest. This observation was contrary to the predicted outcome.

A second prediction was that the *Location* characteristic would be a strong driver of the *Uninterrupted business* and *System compatibility* value interests. *Location* refers to the extent of existing development and infrastructure and distance from owner's current operations. As the distance from current operations decreases and the degree of existing infrastructure increases, one would expect the ability to perform construction activities and tie into existing systems with the least interruption would become more important.

This was supported by the estimated model parameters. The *Location* parameters for *Uninterrupted business* and *System compatibility* were -0.57405 and -0.41529, respectively. Recalling Equation 6, a negative parameter means the importance of the value interest increases as the characteristic level decreases. In the case of *Location*, a decreasing characteristic level means the construction activities are becoming closer to existing operations and infrastructure is increasingly available and, as this happens, the negative parameter will cause the two value interests, *Uninterrupted business* and S*ystem compatibility* to become more important to the project, which is intuitive.

As specified by the CII study, the *Technology* of a project refers to the degree of maturity and commercialization, the extent of modifications required and the complexity of the technology, as well as how familiar the project team is with its implementation. If a project requires implementation of a highly complex technology with little previous commercialization, it would be expected that protection of intellectual property would be a priority. This relationship was confirmed in the estimated parameter of *Technology* in the *Intellectual property* value interest model.

Many other such intuitive relationships were observed in the parameter estimates. For example, as the contractor's responsibility for project development and execution activities increases (i.e., the project *Type* characteristic increases), so does the need for *Business confidence and satisfaction*. The project characteristic that is the strongest driver of the value interest *Validation-ability* is *Regulation*. *Regulation* is also the characteristic that most strongly governs the importance of *Green construction*, *Experience with regulatory compliance*, and *Environmental impact*. The relationships defined by the parameter estimates and discussed so far have all been intuitive.

There were some relationships, however, which were anticipated but not supported by the parameter estimates or were observed in the estimates but not anticipated prior to modeling. For instance, *Regulation* should be a strong driver of *Cleanability for regulatory purposes*. Nevertheless, that characteristic was not sufficiently statistically significant to be retained in the *Cleanability* model and, thus, does not contribute mathematically to its importance. Similarly, it would be anticipated that as the level of *Involvement* of the owner decreases and the level of responsibility of the contractor increases (the project *Type* increases), the importance of the value interest *Degree of Transparency* would increase. This was not the case, however, as these two characteristics were not significant and were not retained in that value interest model. Instead, the two strongest drivers of *Degree of Transparency* were *Cost driven* (positive parameter) and *Complexity* (negative parameter). This means that the *Degree of transparency* becomes more important as the project becomes more cost aware (positive parameter, this makes sense) *or* less complex (negative parameter, does not make sense). Another observed anomaly was the negative parameter estimate for the *Size* characteristic in the *Meet the cost objective* value interest model. The parameter is quite small (only -0.08228) so it does not substantially influence the model but it indicates the importance of meeting the target budget decreases (albeit an almost negligible amount) as the cost of the project increases. Though there is no immediately intuitive explanation for these incongruities, it is likely they are a result of unobserved interaction between multiple value interests or characteristics.

CHAPTER VII

CIIVALUESHARE TOOL

The goal of the CII study was to develop an instrument that could be utilized to obtain and communicate a set of recommended value interests. This instrument would not just provide a list of value interests but would also assist the owner in specifying the relative relationship between the value interests, develop a system of units and measurements to gauge achievement of the value interests, and establish procedures to manage potential conflicts between the value interests. This tool would be valuable to an owner not just as a means of communicating fundamental project expectations to the E&C but also as an internal alignment exercise among owner stakeholders. It was not intended, however, to be implemented solely by owners. In the event an owner does not know their project value interests or they have not been communicated, the tool could also be used by the E&C to determine what they may be.

The final tool actually contains two modules: a value interest identification module and an E&C response module. The E&C response module provides a set of suggested responses to aid in achievement of the owner's project value interests. Since both of these modules were intended to be implementable by both the owner and E&C, they were integrated into a single tool, the *CIIValueShare Tool* (for screenshot, see Appendix D). The methodology used to develop the E&C response module, however, was not part of the scope of this thesis and further discussion of the module will be limited.

OWNER PERSPECTIVE

Fig. 7 shows how the tool could be used by an owner. An owner that desires assistance in identifying their value interests would first start with the *Value Interest Module*. The first step in this module is to describe the project. From this description, the module then produces a list of value interests organized in order of (recommended) relevance to the project. Since the recommendations made by the tool are a reflection of the industry average, the tool user is given the flexibility to either keep the value interests recommended by the tool or to customize their value interest selections by choosing from a larger, comprehensive list. The owner is then asked to weight the value interests by assigning each a number (0 to 100) that reflects how important, or *how value-adding*, the owner believes that value interest to be to their project. Next, the module checks the owner's list of value interests to see if there are any that could potentially be incompatible. If incompatibilities are found, the owner is asked to specify how they would like the conflict to be handled should it occur. If none are found, the owner proceeds to the final two steps. In these steps, the owner is walked through establishing the units/measurements by which achievement of the value interests will be assessed, the level to which they must be attained, and whether they are willing to accept a deviation from the level they have requested (trade-off). At the end of this process, the owner will receive a report summarizing all of their input. They can choose to keep this report for internal documentation or give it to the E&C as part of the RFP package. A sample report is provided in the Appendix D. Upon completion of this module, the user may continue on to the *E&C Response Module*, if desired.

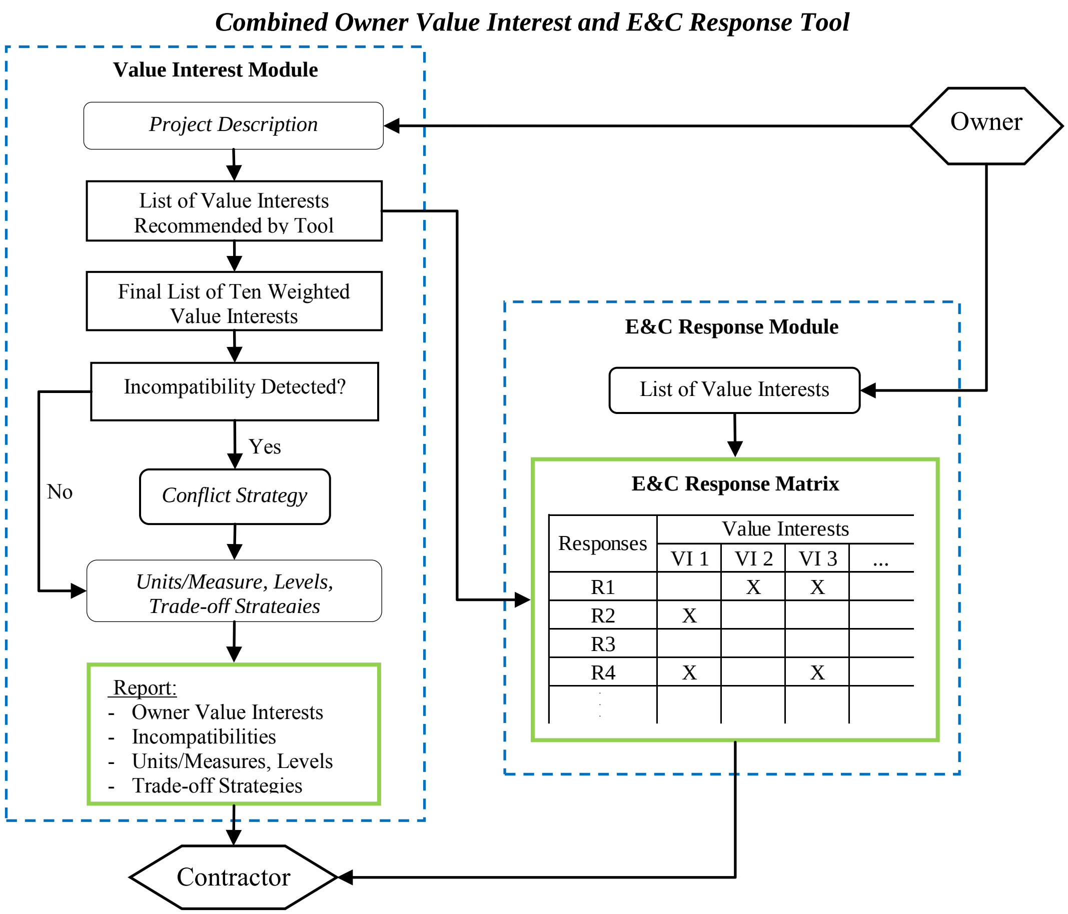

Fig. 7. Tool Utilization from Owner Perspective

E&C PERSPECTIVE

From the perspective of an E&C, this process is simpler. An E&C could use the *Value Interest Module*, together with the project description provided in the RFP, to determine what the owner's value interests may be and then proceed to the *E&C Response Module* to obtain a set of suggested responses. If the owner has already provided its value interests, the E&C may proceed directly to the E&C Response Module to obtain the recommended responses. Fig. 8 shows these two approaches.

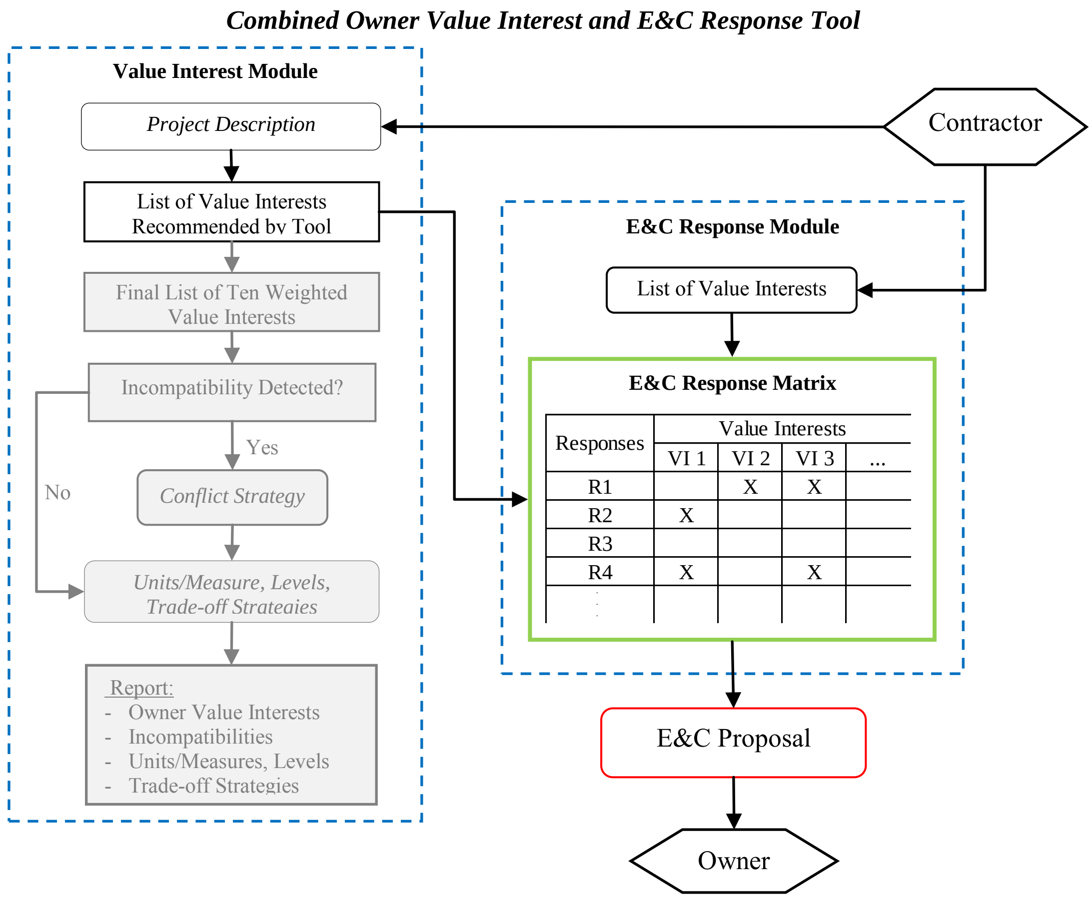

Fig. 8. Tool Utilization from E&C Perspective

TOOL VALIDATION

To validate the tool, a pilot test was performed by six owner, contractor, and supplier companies. The participants used the tool to identify their project specific value interests and reported back on the applicability and usability of the tool. In the Excel file, the project characteristics were presented to the user as a series of eleven multiple choice questions. The user was then presented with a list of value interests prioritized in an order determined by the model and the project characteristic selections.

A few participants commented that there are too many value interests and that some appeared to be repetitive, especially the two cost and two schedule related value interests. In the beginning, the consequence of including too many value interests was considered. In addition to potentially being overwhelming to someone implementing the model on their project, including too many value interests could potentially dilute the importance of the applicable value interests. The goal was to include the core value interests that are present on almost all projects – cost, schedule, and quality, in some form – but also to include the less common and more specific value drivers that make a project unique. In addition, it was recognized that not all projects are minimum cost or shortest schedule but, instead, have the flexibility of balancing the cost or schedule objectives against other critical project values. Thus, the final list of value interests was extensive and includes two cost and two schedule terms to allow an owner to differentiate between the need to achieve a specific budget or completion time and the desire to balance all critical project objectives. The broad nature of the set of value interests means not all value interests will apply to every owner or project.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

This thesis set out to test, through development of a mathematical model, the hypothesis that *project characteristics drive value interests*. With the assistance of a CII study, 48 value interests and 11 project characteristics were enumerated and defined and an industry survey provided value interest preference data for 190 projects. Through binary logistic regression of the survey data, a mathematical model reflecting the relationship between project characteristics and value interests was developed. The mathematical model contained only those characteristics that were statistically significant in explaining the applicability of value interests and the model was validated empirically by comparing the model recommendations to the preferences expressed in a randomly selected set of surveys.

Development of the model showed that, indeed, some project characteristics do drive value interests. Further, since not all characteristics contributed significantly in explaining each value interest, this shows that there is neither a single, overshadowing characteristic nor a standard set of characteristics that drive all value interests. Instead, each value interest has its own unique combination of characteristics that contribute to its presence on a given project.

A sensitivity analysis was performed for the two value interests *Meet the Cost Objective* and *Meet the Schedule Objective* to determine the sensitivity of their recommended rankings to changes in project characteristic parameter estimates. The analysis revealed the recommended rankings of these two value interests are not significantly sensitive to changes in the parameter estimates of *Location*, *Technology*, and *Nature*. The recommended rankings did exhibit a greater degree of sensitivity to changes in the estimates of the other eight characteristics – *Size*, *Complexity*, *Type*, *Involvement*, *Importance*, *Cost-driven*, *Schedule-driven*, and *Regulation* – which indicates these characteristics may contribute a greater degree to the overall value set of a project than the other three.

Examination of the estimated model parameters revealed some characteristics are stronger drivers of individual value interests than others. For example, the *Cost*- and *Schedule-driven* characteristics showed significantly more influence on the *Meet the cost objective* and *Meet the schedule objective* value interests, respectively, than did other characteristics. The characteristic *Location* was found to be a strong driver of *Uninterrupted business* and *System compatibility*. *Regulation* was the strongest driver of *Validation-ability*, *Green construction*, and *Experience with regulatory compliance*. The parameter estimates indicate that, as stated previously, value interests are driven by a combination of many project characteristics, not just one.

A closer look at the survey data provided some insights. First, all 48 of the value interests were selected by survey participants indicating that, although the list is extensive, there are no extraneous value interests among the 48. This also means survey respondents believe this level of communication, the more specific or granular communication provided by the 48 value interests, is valuable. Finally, a comparison of owner and contractor value interest choice frequencies showed the two groups' selections followed a distinctly similar pattern. Those value interests selected most frequently by one group were also those selected most frequently by the other group. This may indicate both groups view value interests with similar importance.

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APPENDIX A: DEFINITIONS

Value Interest Definitions

Ability to meet the specified facility life span - The utilization of material, equipment, and construction details to achieve the planned life cycle of a facility.
Ability to meet the specified facility reliability - The execution of design, procurement, construction, start-up/commissioning, and operation tasks to achieve the owner defined reliability criteria.
Accessibility of the facility - A holistic approach to the design of public access (pedestrian and vehicular) of a facility to enhance user experience, define handicap accessibility, and ensure separation between public and operational vehicular access.
Allocate/Share risks - The extent to which the contracting strategy allocates project risks to the party which has the greatest ability to control the risks.
Business confidence and satisfaction - The degree of confidence and/or satisfaction an owner has in the integrity, experience, financial stability, and quality of work of a contractor so the owner knows the level of responsibility that can be placed on the contractor.
Cash flow control - The availability of flexible cash flow solutions that allow an owner to assume less cost escalation risk and spread funding across fiscal periods.
Clean-ability (during operations) - The degree to which components, equipment, and systems (including supporting structures) are designed to promote a clean environment that meets owner, product, Current Good Manufacturing Process (CGMP), and regulatory requirements.
Clean-ability (for regulatory purposes) - The degree to which design and construction of facilities and equipment promotes a clean environment to meet regulatory requirements.
Constructability - The incorporation of construction knowledge into design to streamline project execution and reduce construction time and cost, scope changes, and re-work.
Degree of transparency - The degree to which the actions, expectations, and outcomes of each project participant (owner, contractor, etc.) are identified and communicated to all parties to improve team alignment, thus minimizing conflict and creating a "win-win" atmosphere.
Design team experience/competency - The level of experience and competence of a design team with regard to the ability to provide practical solutions to reduce project risk, cost (capital or life-cycle), and schedule.
Diversity (e.g. Disadvantaged Business Enterprise) - The attainment of a broader project viewpoint and alignment with regulatory or corporate requirements through the involvement of small, minority, and women owned business enterprises in the design, supply, and construction phases.
Documentation (e.g. scaled models, 3D/4D) - The ability to develop and maintain documentation to support operations and maintenance.
Energy Efficiency - The minimization of energy inputs and/or maximization of energy recovery efforts to achieve capital and operating cost objectives and energy related environmental goals.

Environmental impact (including carbon footprint) - The reduction of negative effects of a project on the environment during the execution and operational phases. This includes recycling, reutilization, and reduction of GHG and the generation of carbon credits.

Experience with regulatory compliance - The demonstration of experience regarding required technical specifications, qualifications, performance, and operability in order to meet a federal, state, county or local law.

Facility security - The protection of physical systems and assets, personnel, and information against theft, sabotage, and terrorism.

Financial stability of suppliers - The degree to which suppliers remain fiscally sound so that there is low risk of supply irregularities, such as delays, or reductions in product quality or support.

Flexibility to defer project - The ability to phase project construction and delivery to allow an owner to stage funding or address uncertainties such as changing scope or market requirements.

Green construction (e.g. Leadership in Engineering and Environmental Design) - The incorporation of sustainable design, construction, and operating practices into project execution to promote corporate objectives and meet construction and operating cost objectives.

Intellectual property - The protection of inventions, trademarks, designs, and other intellectual property from infringement that could result in financial or market share loss.

Life-cycle cost of equipment - The development and implementation of a design approach for equipment reliability and asset management to achieve the desired life and operating conditions for minimal cost.

Long-term partnering – An owner's utilization of the same contracting partner(s) for multiple projects to take advantage of the partner's knowledge of owner schedule, procedures, methodology, and work philosophy, as well as facilitate the development of a long-term relationship.

Maintainability - The ease with which a system can be inspected and maintained to minimize failures and production losses.

Maintenance cost - A holistic approach to life cycle cost and commissioning in which there is a focus on designs that minimize the cost of maintenance.

Material sourcing/engineering restrictions - The degree to which owner and regulatory agencies specify or restrict the sources of materials, services, technology, or suppliers of equipment and components in an effort to maintain greater control over quality, increase operational consistency, and minimize costs and personnel training.

Meet the cost objective - The extent to which the baseline or target cost objective is achieved by the project team.

Meet the schedule objective - The extent to which the baseline or target schedule objective is achieved by the project team.

Operability - The design of a facility to make operations safer and more efficient, less costly, and minimize downtime/turnaround.

Operating cost - The identification of the lowest possible operating costs including energy utilization, maintenance, operations personnel, turn-around time for equipment and materials, and warehousing over an owner-defined time period.
Optimum cost – Balancing the project cost objectives against all other value interests to obtain the best overall achievement of the project objectives.
Optimum schedule – Balancing the project schedule objectives against all other value interests to obtain the best overall achievement of the project objectives.
Process Efficiency (during Operations) - The degree to which resource (raw material, energy, time, manpower, etc) consumption during facility operations meets the specifications of the owner.
Process flexibility - The degree to which the project design allows for variation in capacity or composition to maximize the efficiency of the process, minimize future expansion costs, and meet variation in production requirements resulting from changes in the marketplace.
Procurement competency - The degree to which the contractor can provide competent procurement professionals, systems, and supplier relationships so that project is appropriately supplied.
Product Quality - The design, construction, and assembly of facilities and equipment in a manner that promotes a predictable product quality to minimize losses, maintain regulatory compliance and increase customer satisfaction.
Project stakeholders' involvement - The level and quality of input from project stakeholders, including owner(s), contractor(s), suppliers, and customers, to produce a higher quality project and increase the satisfaction level of all parties.
Public image - The degree of support, opposition, or indifference the public and surrounding communities holds for a facility location or process and, therefore, may impact project objectives.
Repair-ability - The ease with which a damaged or failed equipment, component, machine, or system is cost effectively restored to acceptable operating condition to minimize downtime and replacement costs and provide for identification of the failure migration path.
Repeatability/Consistency of a product - The development and implementation of a design approach to ensure variations in product specifications stay within owner and regulatory defined ranges, resulting in predictable product performance and composition.
Single point of responsibility for project execution – The control and management of all contracted entities (engineering, vendors, suppliers, and subcontractors) by a single party so that the project has more coordinated controls and communication.
Standard work processes – A set of predetermined and agreed upon work methods and processes (including change management) that will be shared by the owner and contractor in an effort to increase communication, delegate control, and reduce schedule and costs.
System compatibility (Integration with existing systems) - The degree to which added or modified systems, structures, components, and equipment are assured to be compatible when interfacing existing components and systems to reduce the requirement for operator training and the impact on operating assets.

Training - The degree to which training or instruction is provided to operators to minimize operational errors, reduce costs, improve safety, and enhance the potential of the operator.

Uninterrupted business - The ability of a facility to continue operations to the degree specified by the owner while undergoing or adjacent to major renovations or additions.

Utilization of local engineering, vendors, suppliers, materials, and content -The degree to which an owner requires utilization of local engineering services, vendors and suppliers, and material sources to reduce shipping costs, increase reliability of deliveries, meet local government requirements, or gain organized labor or community acceptance.

Utilization of subcontractors/vendors - The degree to which an owner accepts the use and administration of subcontractors and vendors based on alliance, preferred supplier, and lowest cost and gauged against constraints for desired terms and conditions (i.e. LD's, warranties, rework, identification, consequential damages, etc).

Validation-ability (regulatory compliance) - The degree to which design and documentation of a facility and its installed systems allows for validation of regulatory compliance with the least interruptions to operations and minimal lost time and revenue.

Project Characteristic Definitions and Levels

Industry – In which industry is the project or owner?

1. Commercial or Public Buildings
2. Infrastructure
3. Manufacturing
4. Oil/Gas Recovery
5. Pharmaceutical
6. Power
7. Process
8. Refining/Chemical

Location - How would you describe the location of your project relative to owner's current operations and existence of infrastructure?

1. It is an established location with existing infrastructure and owner operations or presence
2. It is a new Owner location with existing infrastructure
3. It is a new Owner location with developing infrastructure
4. It is a frontier location with limited to some infrastructure
5. It is a frontier location with limited to no existing infrastructure

Size - What is the size of your project in US Dollars?

1. $10M and less
2. $10M to $50M
3. $50M to $250M
4. $250M to $1B
5. $1B and larger

Technology - How would you describe the extent of technology as it relates to the degree of maturity and complexity of the technology, the extent of modifications requires, and how much experience the owner has with it?

1. It is common and/or repeatable, the owner has extensive experience with it, and there are no anticipated complications
2. It will require modification/scaling of existing technology, the owner has extensive experience with it, and there are no anticipated complications
3. It has average maturity and/or complexity and the owner has some (but not extensive) experience with it
4. It has limited commercialization and/or unknown scalability and the owner has limited experience with it
5. It is ground-breaking with no previous commercialization and the owner has no experience with it

Complexity - How complex is the design, construction, and funding of your project (includes new/unfamiliar design or construction tools and methods, level of scope definition, and funding source(s))?

1. The complexity is very low. The project uses established design specifications and tools and has a very well defined scope of work/project definition

2. The complexity is low. The project uses established design tools and minor design specification revisions are required
3. The complexity is medium. The project uses established design tools and/or process steps, some new design specifications are required and there are some deficiencies in the scope of work/project definition
4. The complexity is high. The project uses some new design tools, significant design specifications are required and there are major deficiencies in the scope of work/project definition
5. The complexity is very high. The project uses new design tools, all new design specifications are required, and the project has an undefined scope of work/poor project definition

Project Nature - What is the nature of your project (the work to be done and the extent of change to the facility)?

1. It is an add-on project constructed on a Brownfield site. The project will add extra processing steps where a process did not previously exist
2. It is an expansion project constructed on a Brownfield site. The project will increase the capacity of an existing facility of the same type and at same site
3. It is a revamp project constructed on Brownfield site. The project will remove a bottleneck, rebuild, or refurbish an existing operation
4. It is a co-located project constructed on Greenfield site that is adjacent to an existing facility. The project is standalone except utilities and infrastructure
5. It is a greenfield project constructed at a new, undeveloped site with unknown geographic data

Type of project - What is the scope of work/services for which the contractor will be responsible?

1. The E&C is responsible for Front End Engineering Design (FEED), including development of the conceptual design and cost estimate to allow the project to proceed to Detailed Engineering
2. The E&C is responsible for FEED and Detailed Engineering (DE), including development of the design to the “Approved for Construction” status
3. The E&C is responsible for FEED, DE, Procurement, and Construction (design development, material purchasing/ expediting/ inspection/ logistics and construction)
4. The E&C is responsible for DE, Procurement, Construction (design development, material purchasing/ expediting/ inspection/ logistics and construction) but not FEED
5. The E&C is responsible for Procurement and Construction (material purchasing/expediting/inspection/logistics and construction) but not FEED or DE

Owner's Involvement - What is the anticipated level of Owner participation and control of design in the project?

1. The level of owner involvement is very low. Responsibility for all engineering, procurement, and construction lies with contractor and clear performance specifications are required
2. The level of owner involvement is low. The Owner is performing the conceptual engineering and the remaining design, procurement, and construction is performed by the E&C

3. The level of owner involvement is medium. The Owner is performing the conceptual and preliminary engineering and the detailed design, procurement, construction is performed by the E&C
4. The level of owner involvement is high. The Owner is performing the conceptual, preliminary, and some detailed design and the remaining design, procurement, construction is performed by the E&C
5. The level of owner involvement is very high. The Owner is performing all design development with little or no assistance from the E&C. The E&C is providing construction only

Importance - What is the importance of the project to the Owner's organization?
NOTE: The importance of a project can refer to strategic business-related projects, discretionary or non-discretionary projects, etc.

1. The importance of the project is very low.
2. The importance of the project is low.
3. The importance of the project is medium.
4. The importance of the project is high.
5. The importance of the project is very high.

Cost Driven - To what extent is the project driven by cost?

1. The Owner wishes to execute the project for the least cost to be in compliance with Regulations; the project is required to meet local, state or federal regulations
2. Cost is a non-factor; the project is performed due to maintenance or operations requirements and must be completed or operations will cease. In this case, the production loss outweighs the project costs
3. Cost is of little consequence; the project is undertaken to significantly increase performance and will result in a high Return on Investment. In this case, cost is of minor concern
4. Cost is a moderate factor; this is a typical project in which cost must be held in check based on the initial estimate and allocated funds
5. Cost is a key driver; the project is Government tendered or the project is significant in cost compared to the Owner's market capitalization. In this case, excess costs must be approved

Schedule Driven - To what extent is the project driven by schedule?

1. There is no schedule compression or deviation from normal or accepted scheduling practices
2. There is less than 5% schedule compression and minor deviations from normal or accepted scheduling practices
3. There is between 5% and 10% schedule compression and some deviation from normal or accepted scheduling practices
4. There is between 10% and 15% schedule compression and significant deviation from normal or accepted scheduling practices
5. There is greater than 15% schedule compression, possible regulatory requirements, and significant deviation from existing scheduling practices

Regulation - What is the extent of regulatory compliance required for this project?

NOTE: Regulatory compliance could be affected by the owner's level of experience, the project location, the regulatory environment, etc.

1. The impact of regulatory compliance on this project is very low.
2. The impact of regulatory compliance on this project is low.
3. The impact of regulatory compliance on this project is medium.
4. The impact of regulatory compliance on this project is high.
5. The impact of regulatory compliance on this project is very high.

APPENDIX B: SURVEY

Owner Value Interest Survey

Name:

Company:

Email:

Phone:

Date:

The ***purpose*** of this survey is to identify the relationship between different sets of project characteristics and owner value interests. This data will be used to develop a tool with which an owner will be able to identify the value interests applicable to their project based on their project's characteristics. This Owner Value Interest Identification tool will be the first of a series of two tools. The second tool will provide a contractor response, including resources and strategies, appropriate to the value interests identified by the first tool.

Instructions: *It is important to take an* ***owner's perspective*** *when completing this survey.* There are three steps to this survey. In Step 1, you will be asked to use your past experience to describe a ***completed*** project using pre-defined project characteristics. In Step 2, you will be asked to identify, from a list, the ten owner value interests that are most applicable to each project. In Step 3, you will be asked to weigh the ten owner value interests you chose based on their applicability or importance to the project you have described. ***Please complete these three steps for three projects (see tabs below)***. An *Owner Value Interest* is an owner-defined project attribute that adds value to the organization, such as safety in operations and cash flow control. A *Project Characteristic* is a feature that effects, governs, or determines a value interest(s), such as industry type and project size and location. Definitions for each of the owner value interests and project characteristics used in this survey are provided in the glossary. In addition, hovering the mouse over the cells in the list of owner value interests (at the bottom of each Survey page) will display a definition of the term.

Fig. B - 1. Welcome Page of Value Interest Survey

Step 1: Project Description

Please describe a ***completed*** project with which you were involved using the highlighted cells below. Please select the cell and use the drop-down menu that appears to the right of the cell to view and select the characteristic which best describes your project. Definitions for each of the project descriptor terms have been provided in the Glossary (see tab below).	
Industry Type:	8 - Refining/Chemical
Location:	3 - New Owner location, developing infrastructure
Size:	3 - $50M to $250M
Technology:	3 - Average maturity/complexity; owner has some (not extensive) experience
Complexity:	2 – Low – Minor design specification revisions required; established design tools
Project Nature:	5 – Greenfield – Project constructed on new, undeveloped site with unknown geographic data
Type of project:	3 – FEED, DE, Procurement, and Construction – design development, material purchasing/ expediting/inspection/logistics and construction
Owner's Involvement:	4 – High - Owner performs conceptual/preliminary and some detailed design; remaining design, procurement, construction performed by contractor
Strategic Importance:	3 – Medium, an average project with typical Return on Investment such as additional capacity for an established facility
Cost Driven:	4 – Cost is a moderate factor – Typical project in which cost must be held in check based on initial estimate and allocated funds
Schedule Driven:	4 – Between 10% and 15% schedule compression; significant deviation from normal or accepted scheduling practices
Regulation:	4 - High – A strict regulatory environment where the owner has little prior experience

Fig. B - 2. Step 1 of Value Interest Survey (Example Response)

Step 2: Value Interest Selection

For the project you described, please indicate the ten most applicable value interests (scroll down to see the list below) in the highlighted cells below. When a cell is selected, a drop-down menu will appear to the right of the cell. Definitions are provided below and in the Glossary	
Value Interest 1:	System compatibility
Value Interest 2:	Process flexibility
Value Interest 3:	Operability
Value Interest 4:	Optimum schedule
Value Interest 5:	Product Quality
Value Interest 6:	Maintainability
Value Interest 7:	Environmental impact
Value Interest 8:	Ability to meet the specified facility reliability
Value Interest 9:	Business confidence and satisfaction
Value Interest 10:	Utilization of local engineering, vendors, suppliers, materials, and content

Fig. B - 3. Step 2 of the Value Interest Survey (Example Response)

Step 3: Value Interest Weighting

Where highlighted below, please weigh the value interests you chose in Step 2. Please weigh each value interest based on its importance or applicability to the project you described. Please use whole numbers and chose weights such that the sum of all ten weights equal 100.

Value Interest 1:	System compatibility	15
Value Interest 2:	Process flexibility	15
Value Interest 3:	Operability	15
Value Interest 4:	Optimum schedule	10
Value Interest 5:	Product Quality	10
Value Interest 6:	Maintainability	15
Value Interest 7:	Environmental impact	5
Value Interest 8:	Ability to meet the specified facility reliability	5
Value Interest 9:	Business confidence and satisfaction	5
Value Interest 10:	Utilization of local engineering, vendors, suppliers, materials, and content	5
	Total	100

Fig. B - 4. Step 3 of Value Interest Survey (Example Response)

APPENDIX C: PARAMETER ESTIMATES

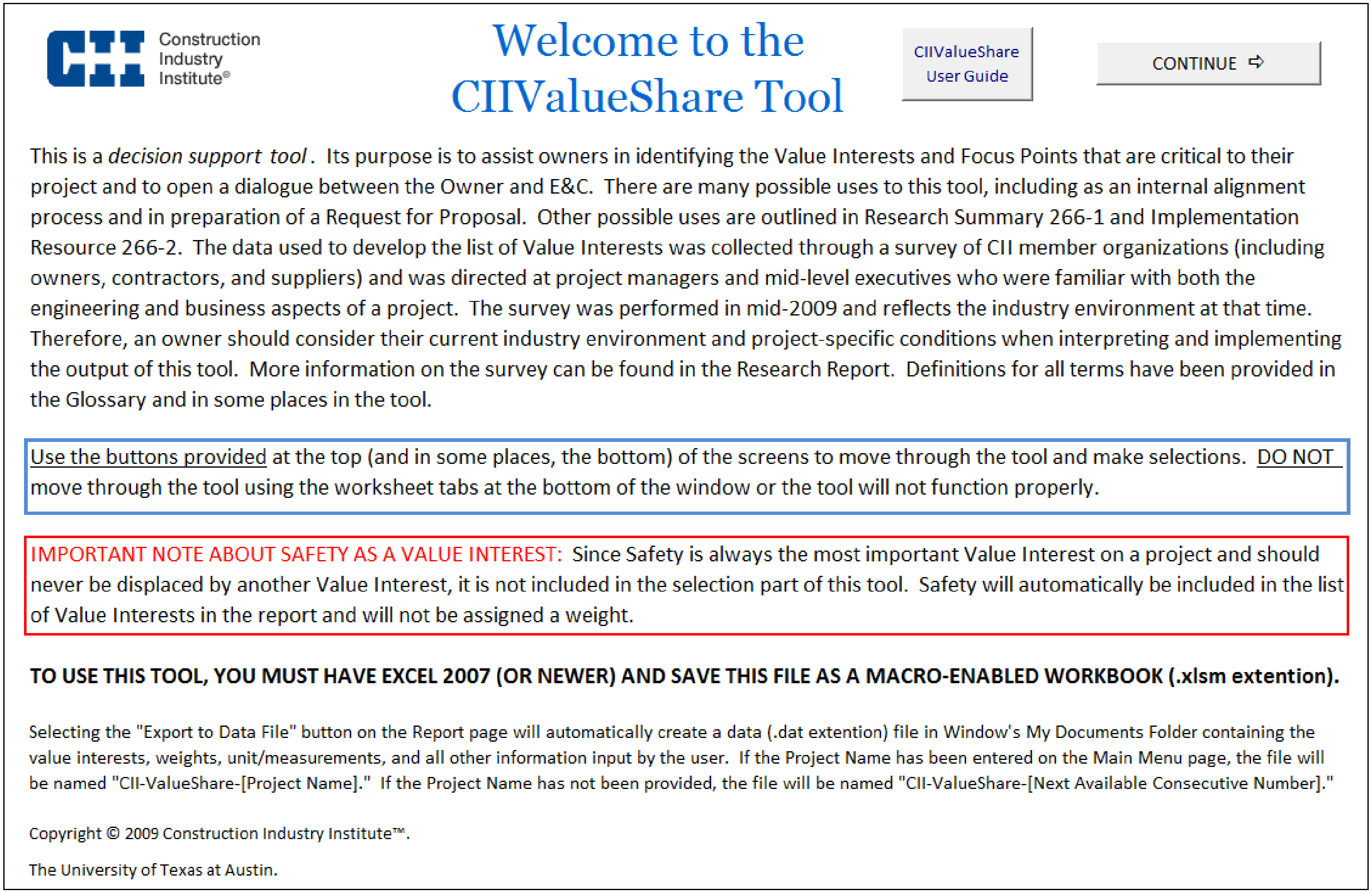
	Intercept	Location	Size	Technology	Complexity	Nature	Type	Involvement	Importance	Cost	Schedule	Regulation
Optimum cost	-1.76105	-0.07438		-0.09755	-0.07644		0.06591	0.24125	-0.22789	0.11593	-0.05494	-0.17896
Process flexibility	-2.73379	0.22616		0.13501			-0.25625	-0.29003	0.19301	-0.20242	0.08605	-0.16337
Utilization of subcontractors/vendors	-4.13598	0.34263	-0.44233	-0.46477		0.17385						
Operability	-2.26236	-0.09605		0.06121				0.10323		-0.10236		-0.12377
Flexibility to defer project	-7.06600	0.39960	0.39430		0.80000	-0.39260	-0.43980	0.53390	-0.99750		0.72800	-0.34450
Constructability	-1.34538		0.07333				-0.38430	0.15375	-0.17622	-0.17616	0.05544	
Cash flow control	-1.88367	-0.29272	0.36842	-0.45934		0.16588		0.17363	-0.24100	-0.22601	0.11772	-0.65556
System compatibility	-1.74987	-0.41529			0.11823	-0.40190	0.16269	0.16333	-0.14364		-0.16322	-0.24162
Maintainability	-2.73940	0.07510	0.08447	-0.07166		-0.10035			-0.21699	0.13504		
Clean-ability (during operations)	-6.59751		-0.19948		0.81358				0.18881	-0.21041		
Utilization of local engineering, etc.	-4.04258	0.31465	0.33531		-0.23200	-0.26041		-0.22333				
Material sourcing/ engineering restrictions	-5.70309	0.37727		0.27809			0.42731		-0.62693		0.19456	-0.21216
Optimum schedule	-3.96264			-0.13495	0.14052		0.17072	0.21273	-0.11328	0.12156		-0.08977
Product Quality	-3.95447	-0.17126		0.24082	0.17543	0.18173		0.17219				-0.20474
Repair-ability	-0.63907	0.42335	-0.51493			-0.63352	-0.78549	0.82800	-0.38321	-0.17693		-0.38815
Uninterrupted business	-2.46235	-0.57405	-0.07221	-0.10687	0.08999	-0.19626	0.13500	-0.12330	0.26163		-0.27218	0.27550
Allocate/Share risks	-4.95443	-0.31655	0.78787	0.27303			-0.30860	-0.36568		-0.16130		
Meet the cost objective	-2.96316		-0.08228	-0.05897			-0.17533	-0.09135		0.19785	0.08277	0.21204
Repeatability/ consistency of product	-5.58806		0.27305			-0.22750	-0.45280		0.73526		0.55288	-0.87605
Environmental impact	-3.65640		-0.27667	0.18628	-0.17949	-0.11883	-0.48715	0.10443	0.22013	-0.41715	0.17884	0.69109
Meet the schedule objective	-1.29242		-0.21150	-0.09621	-0.18381		-0.06490	-0.24539	0.12840	-0.09336	0.22935	0.06944
Ability to meet the specified facility reliability	-5.28639	-0.20406	0.22651		0.12122	0.20745	0.11857		0.23109		-0.29491	
Facility security	-4.57093			-0.97916	0.85100		-0.43475		0.73902	-0.39724	-1.24413	0.51324
Accessibility of the facility	-0.77320		-2.25060	-0.50380				-0.76350		-0.47060		1.24110

Fig. C - 1. Table of Parameter Estimates for Value Interests 1 – 24

	Intercept	Location	Size	Technology	Complexity	Nature	Type	Involvement	Importance	Cost	Schedule	Regulation
Ability to meet the specified facility life span	-8.29820	0.71550				-0.84240				0.70420		
Validation-ability	-7.44092	0.18677	-0.28360	-0.17684	0.29357	-0.19007	1.07334	-0.31058		-0.21773	-0.23109	0.68014
Clean-ability for regulatory purposes	-5.41694					0.25215		0.21051			-0.50000	
Maintenance cost	-5.63205		0.46997	-0.20230	-0.22910			0.18291				
Business confidence and satisfaction	-5.98151			0.30233	-0.25500	0.22728	0.36358					
Operating cost	-5.69049	0.21504		0.30032	-0.33985					0.26372	0.21067	
Energy Efficiency	-8.38910	-0.21796	0.31499	0.27880	-0.34852	0.44336	-0.31494	0.23434		0.34364	0.15577	0.32478
Life-cycle cost of equipment	-8.97598		0.43924	0.26382						0.46485	-0.24020	0.32014
Process efficiency (during operations)	-7.39920	0.19585	0.64599	0.16406			0.35261	0.23889	-0.34996	-0.14966		0.13528
Long-term partnering	-6.22282			-0.17665		0.25517				0.37338	-0.25337	
Procurement competency	-7.40039		0.34885					-0.43908	0.84561			-0.42855
Training	-6.16790					-0.30940	0.58700	-0.27430				
Public image	-8.47415	-0.51439	-0.50552	-0.85303		0.82542		-0.25706	0.90261			0.62446
Design team experience/ competency	-3.03447			0.12547	0.20433			-0.19610	-0.32406		0.15268	
Experience with regulatory compliance	-5.89145	0.34833	-0.28394	-0.21422			0.23585	-0.25775		-0.20123		0.76875
Green construction	-6.39150		-0.48980	-1.12960			0.51480	-0.69170	-0.35850			1.32460
Single point of responsibility for project execution	-4.75671	-0.22269	0.23475	0.23728	-0.13825	0.24222	0.42602	-0.33435				-0.43595
Diversity	-8.58340	0.88140		-0.57110	0.68970		0.96940	-1.46940	-0.48060		0.32310	
Project stakeholders' involvement	-2.02688		-0.30358				0.21785	-0.84085	0.27400		-0.48522	
Financial stability of suppliers	-18.37870			0.53300		1.76470	1.45490				-0.71300	
Documentation (e.g. scaled models, 3D/4D)	-5.70605	0.18651	-0.61288	-0.30696	0.45803	-0.33366	0.29527	0.49629	-0.39819			0.26491
Standard work processes	-4.49876	-0.38483				0.39326			-0.55023	0.20960		-0.26551
Degree of transparency	-10.04540	0.37529	0.21830		-0.89914	-0.38390			0.67605	0.88998	0.23453	
Intellectual property	-8.67002		-0.48090	0.69172	0.87808	0.43379	-0.41448		0.53486	-0.21982		-0.50962

Fig. C - 2. Table of Parameter Estimates for Value Interests 25 – 48

APPENDIX D: CIIVALUESHARE TOOL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Welcome to the CIIValueShare Tool

CIIValueShare User Guide

CONTINUE

This is a *decision support tool*. Its purpose is to assist owners in identifying the Value Interests and Focus Points that are critical to their project and to open a dialogue between the Owner and E&C. There are many possible uses to this tool, including as an internal alignment process and in preparation of a Request for Proposal. Other possible uses are outlined in Research Summary 266-1 and Implementation Resource 266-2. The data used to develop the list of Value Interests was collected through a survey of CII member organizations (including owners, contractors, and suppliers) and was directed at project managers and mid-level executives who were familiar with both the engineering and business aspects of a project. The survey was performed in mid-2009 and reflects the industry environment at that time. Therefore, an owner should consider their current industry environment and project-specific conditions when interpreting and implementing the output of this tool. More information on the survey can be found in the Research Report. Definitions for all terms have been provided in the Glossary and in some places in the tool.

Use the buttons provided at the top (and in some places, the bottom) of the screens to move through the tool and make selections. DO NOT move through the tool using the worksheet tabs at the bottom of the window or the tool will not function properly.

IMPORTANT NOTE ABOUT SAFETY AS A VALUE INTEREST: Since Safety is always the most important Value Interest on a project and should never be displaced by another Value Interest, it is not included in the selection part of this tool. Safety will automatically be included in the list of Value Interests in the report and will not be assigned a weight.

TO USE THIS TOOL, YOU MUST HAVE EXCEL 2007 (OR NEWER) AND SAVE THIS FILE AS A MACRO-ENABLED WORKBOOK (.xlsm extention).

Selecting the "Export to Data File" button on the Report page will automatically create a data (.dat extention) file in Window's My Documents Folder containing the value interests, weights, unit/measurements, and all other information input by the user. If the Project Name has been entered on the Main Menu page, the file will be named "CII-ValueShare-[Project Name]." If the Project Name has not been provided, the file will be named "CII-ValueShare-[Next Available Consecutive Number]."

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Fig. D - 1. Screenshot of CIIValueShare Tool

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A&C Refining DATE August 4, 2010

PREPARED BY Susan TITLE PM DEPARTMENT/DIVISION Project Management

PROJECT Cogen Unit PROJECT PHASE Preliminary Design

PROJECT CHARACTERISTICS

Project Location:	It is an established location with existing infrastructure and owner operations or presence.
Project Size (USD):	$10M to $50M
Extent of New Technology:	It is common and/or repeatable, the owner has extensive experience with it, and there are no anticipated complications.
Project Complexity:	Complexity is medium; project uses established design tools and/or process steps, some new design specifications are required and there are some deficiencies in the scope of work/project definition.
Project Nature:	It is an add-on project constructed on a Brownfield site. The project will add extra processing steps where a process did not previously exist.
Type of Project	The E&C is responsible for DE, Procurement, Construction (design development, material purchasing/ expediting/ inspection/ logistics and construction) but not FEED.
Level of Owner's Involvement:	#VALUE!
Strategic Importance to Organization:	The strategic importance of the project is medium, such as an average project with a typical Return on Investment or a project to provide additional capacity for an established facility.
Extent to which Project is Cost Driven:	Cost is a moderate factor; this is a typical project in which cost must be held in check based on the initial estimate and allocated funds.
Extent to which Project is Schedule Driven:	There is between 5% and 10% schedule compression and some deviation from normal or accepted scheduling practices.
Level of Regulation:	The impact of regulatory compliance on the project is medium.

PROJECT VALUE INTERESTS

Value Interest	Weight	Units/ Measurements	Required Level	Justification for Change
Safety				
Meet the schedule objective	35	Months	19.5	Deviation below 19.5 is acceptable; deviation above 19.5 is not acceptable
Optimum cost	20	US Dollars	$50M	Trade cost ($) for schedule
Uninterrupted business	15	Number of hours offline	Maximum 24 hours	Deviation below 24 hours is acceptable; greater than 24 hours is not acceptable
System compatibility (Integration with existing systems)	10	Steam pressure, temperature, etc	600 psig; 700F; 330,000 lb/hr	Deviations below these levels are not acceptable
Design team experience/ competency	5	Number of previous cogen projects	Minimum 4	Less than 4 projects is acceptable if team is known to owner and has other refinery experience
Maintainability	5	Percent of system components that can be visually inspected and/or easily accessed	100% of critical components	No deviations allowed
Operability	5	Operations efficiency (number of people required for management of system)	Small	With increase in automation of operation, required number of personnel can be reduced
Validation-ability (regulatory compliance)	5	Percentage of emitted gasses monitored	1	No deviations allowed

VALUE INTEREST INCOMPATIBILITY

Value Interests		Trade-off Strategy
Optimum Cost	Meet the Schedule Objective	Schedule is primary; trade cost (in $) for schedule (in weeks)

Fig. D - 2. Sample Report from the Value Interest Identification Module

VITA

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